SECTION I:

INTRODUCTION

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PROTECTIVE GLAZING STUDY BACKGROUND

Inspired Partnerships, a not-for-profit organization based in Chicago, IL received a $34,320 grant from the **National Preservation Center** in October 1994 to investigate the virtues and liabilities of various protective glazing installations over stained glass. The study was conducted over an 18-month period from October 1994 to April 1996 and addresses energy, security, sound and light transmission, aesthetic, and conservation issues surrounding the use of protective glazing. Although some aspects of this research are applicable to all protective glazing, the study concentrated on the virtues and problems associated with installations over stained glass in houses of worship. Churches and temples have specific energy, maintenance, and security concerns which tend to be unique to their function, management and operation.

"Protective glazing" (PG) is defined as a secondary layer of sheet glass or plastic on the exterior of a stained glass window. PG is also described as "storm", "double", "outer" and "secondary" glazing and these terms are used interchangeably throughout the study. "Stained glass" pertains to all types of leaded glass. In addition to research, the study included: 1) a stained glass studio survey; 2) a field survey of one hundred PG installations in four different U.S. regions; 3) in-situ testing of two protective glazing installations; 4) an energy model of an intermittently heated building, and; 5) the alteration of ten PG installations.

Inspired Partnerships first assembled a **Protective Glazing Advisory Committee (Committee)** that included the following people: **Rolf Achilles**, Art & Industrial Historian (Chicago, IL); **Arthur J. Femenella**, Stained Glass Consultant with Femenella & Associates (Annandale, NJ); **Dr. Mark Gilberg**, Research Scientist with the National Preservation Center; (Nachitoches, LA), **Thomas Harboe**, Director of Preservation with McClier (Chicago, IL); **Barbara Krueger**, Stained Glass Artist and Historian (Hartland, MI); **Richard Pieper**, Restoration Consultant (New York, NY); **Andrew Rudin**, Energy Consultant (Melrose Park, PA); **Dr. Wayne Simon**, P.E. (Evergreen, CO); and **Neal A. Vogel**, Director of Technical Services with Inspired Partnerships (Chicago, IL). Several Committee members served as authors and editors as well.

Susan Reilly, P.E. of EnerModal Engineering, Inc. was also commissioned by the National Preservation Center to report on the energy value of protective glazing over stained glass. Many other people provided assistance for this study but are far too numerous to mention. However, those who deserve special recognition include: **Susanna Aulbach**, German Translater; **Matthew Bellocchio**, Roche Organ Company; **Chris Botti** and **Mike Smoucha**, Botti Studio of Architectural Arts; **Janice H. Chadbourne**, Curator of Fine Arts, Boston Public Library; **Richard Cieminski**, Jon-Lee Art Glass; **Marit Eisenbeis** and **Charles Kiefer**, Inspired Partnerships; **Betty Kirpatrick**, Hermosa Mountain Studio; **Gabriel Mayer** of Franz Mayer'sche Hofkunstanstalt, Munich, Germany; **Virginia Raguin**, Holy Cross College; **Jack and David Sussman**, J. Sussman, Inc.; **Susan Tunick**, Friends of Terra Cotta; **Theodore Von Gerichten**; **Kirk D. Weaver**, Pittsburgh Stained Glass; and **David Wixon**, Wixon & Associates. **Inspired Partnerships** would also like to thank the numerous stained glass studios provided assistance by completing questionnaires and reporting past experiences with protective glazing.

PG research in the United States cannot be discussed in context without having a firm understanding of subsequent 20th century research in Europe, spearheaded by the **Corpus Vitrearum Medii Aevi (CVMA)**. The **CVMA**, an international research organization dedicated to scientific work concerning medieval stained glass, has held biannual seminars since its inception in 1952. In 1962, a committee within the **CVMA** was formed 1) for research on materials and techniques used in medieval stained and painted glass, and 2) to establish principles and guidelines for conservation and restoration of these (*ed.- stained glass*) endangered works of art.[1]

Although the **CVMA** initially consisted of mostly art historians, membership now includes conservators, restorers and scientists. Some time ago, a **CVMA** newsletter stated that *"protective glazing is the most effective instrument of conservation (ed.- of stained glass) known at present."* Much of this research during the 1970s and 1980s can be attributed to Roy G. Newton who authored The Deterioration and Conservation of Stained Glass: A Critical Biography (1982), which remains among the most important sources on glass conservation to this day. It is important to note that the **CVMA** and its research are only concerned with medieval stained and painted glass. The question is whether these same circumstances apply to stained glass manufactured and painted since the Industrial Revolution.

When the Corpus Vitrearum was formed in Europe in 1952, some U.S. museums were interested, as medieval stained glass was found in most, if not all, of the more prominent American museums. For obvious reasons, academic art historians involved in teaching medieval art, architecture and literature were also interested in research carried out by the **CVMA**. A subsequent survey of medieval stained glass in the United States and the formation of a group involved in the survey, **The Census of Stained Glass Windows in America (CSGA)**, was the vehicle by which European research findings about PG became more widely known.

Stefan Oidtmann's recently published dissertation, Die Schutzverglasung - eine wirksame Schutzmaßnahme gegan die Korrosion an wertvollen Glasmalereien, Technische Universiteit Eindhoven (December 6, 1994), is the most extensive resource on protective glazing to date. Unfortunately, as a dissertation, only a very limited edition has been published in German. The table of contents, appendices, and Chapter III *Construction-related Physical Measurements* were translated for **Inspired Partnerships** to aid this study. This book provides an excellent summary of conservation work at various European cathedrals but is generally limited to medieval stained glass conservation as related to moisture problems.

Nearly all European research has concentrated on moisture related conservation issues and has generally surmised that "isothermal" PG installations are the only way to protect medieval stained glass from deterioration. Such applications are fundamentally and economically impractical for the vast majority of post industrial stained glass in America [see **Section V**].

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[1]Corpus Vitrearum Newsletter 45, Bacher 15.

PROTECTIVE GLAZING PROJECT SCOPE

PROJECT GOAL: **To record and publish a national protective glazing research project to promote higher industry standards for the proper use and installation of protective glazing the United States.**

In order to accomplish the project goal, the **Committee** developed a list of claims to address the myths, facts and hearsay surrounding PG (see the chart on the following page). The **Committee** also developed the following project objectives:

1. **Perform an international literature search on PG over stained glass.**
2. **Provide a historical overview of the development of PG in America.**
3. **Inspect & evaluate a cross section of PG installations in America.**
4. **Create PG models addressing energy performance and interspace conditions.**
5. **Prepare manuscripts to publish for professional/preservation/lay audiences.**
6. **Disseminate the study through the building, preservation & religious networks.**
7. **Identify additional research and testing to be undertaken.**

An international literature search on the history, development and current usage of protective glazing has been undertaken to provide background information for field investigation and the final study. This includes written correspondence to preservation organizations and stained glass professionals in the U.S. and Europe, and an extensive library search (see **Bibliography**). A stained glass studio questionnaire was also published in Stained Glass Quarterly and mailed directly to 200 professionals and studios. Trade literature from manufacturers and promotional literature from stained glass studios was collected to explore how protective glazing is promoted to both the stained glass industry and the consumer.

A field survey of 100 PG installations from four different climatic regions of the U.S. was performed to establish a representative pool of examples. Three primary aspects were evaluated in the field survey: 1) the effects of condensation; 2) heat build-up, and; 3) aesthetics. Ten PG installations in Chicago were removed, modified or replaced to determine the effect of PG over time; to determine changes that occur when unvented PG is vented or removed altogether, and; to experiment with various installation methods. These "case studies" were evaluated further for deterioration, light and sound transmission, and installation methods in collaboration with professional contractors and stained glass studios in Chicago **[see Section VI.]**.

The research results are incorporated in this final study to the **National Preservation Center (Natchitoches, LA).** It includes: the history, development, use and promotion of protective glazing; its prevalence in America; its advantages and disadvantages; data and photos of the 100 installations inspected during the field survey; detailed case studies of ten PG installations; final analysis and general specifications for PG installations, and; supplemental materials. The intent of this study is to develop publishable manuscripts from the study for professional, preservation, and lay audiences after peer review.

The Committee developed the following list of perceived pros & cons in order to separate the myths from facts regarding protective glazing:

PROTECTIVE GLAZING PROS	PROTECTIVE GLAZING CONS
Protects from physical impact (vandalism, storm damage, weather/exposure)	Increases deterioration by condensation and thermal expansion/contraction
Reduces maintenance of window surround	Installation costs
Saves energy and increases comfort (heat gradient)	Negative effect on exterior/interior aesthetics (hazing, frames, conceals tracery, shadow lines)
Reduces sound transmission	Physical damage to frame when poorly installed
Alters light transmission (controlled intentionally)	Adds weight to ventilators affecting operation (piggyback)
Filters ultra-violet light (to protect adhesives in glass repairs)	Eliminates natural ventilation
Stabilizes glass	Breeds complacency towards window maintenance
Reduces air conditioning load	Increases comfort expectations (raising thermostat settings)
Reduces insurance premiums (possibly required for insurance)	Causes air pressure on high windows from wind suction (venturi effect on wayward side of building)
Decreases air (and dirt) infiltration (reducing cleaning)	Reduces light transmission and can mute stained glass colors (hazy, cloudy--particularly plastics)
Economic benefit to stained glass and manufacturing industries	Increases impact damage (spreading bullets, entire panel knocked into stained glass)
Strengthens a weak window frame (acting as a diaphragm)	Prevents emergency ventilation of fires
Keeps moisture & dirt out of plated windows	Increases air conditioning load
Postpones high restoration costs	Weakens some windows
Can be historic	Environmental impact of manufacturing materials
	Postpones installation costs for another generation
	Typically not historic

Protective glazing for stained glass has been used in America since the late 19th century, however, it did not become popular until after W.W. II by filling the void caused by a waning stained glass industry. The civil rights demonstrations of the 1960s, and energy crisis of the 1970s acted as catalysts, and protective glazing evolved into a multimillion dollar industry.

Many stained glass studios and window contractors endorse the use of PG in their trade literature while manufacturers of laminated and tempered glass, acrylics and polycarbonates promote the advantages of their products. Yet, PG may be causing serious damage to many stained glass windows across the country by increasing condensation and heat build-up in the air space and by preventing maintenance.

There are conflicting opinions among stained glass contractors as to the merits, potential problems, and proper installation of PG. While theories and opinions abound, American studies to develop and perform scientific field surveys and tests to separate myth from fact have not been initiated until now. This project frames the debate about protective glazing, dispels many of the misconceptions regarding its usage, and recommends the appropriate installation methods when it is required.

Inspired Partnerships has been documenting PG installations since 1991. Some installations appear to cause no harm, while others appear to cause serious harm. Basic factors such as the age of the installation, window orientation, installation details, humidity, and lighting measurements were recorded during field inspections to develop baseline data. However, because of weather and installation variables, these efforts were too limited to establish clear patterns and accurate information. While most of the stained glass industry, professionals and tradespeople agree that PG should be vented in some manner, it rarely occurs in the field.

The intended audience -- primarily owners of historic churches, synagogues, mausoleums and civic buildings in America -- are the target of numerous claims encouraging PG. Vandalism, street noise, energy losses, and unusual deterioration circumstances all play a role in its use, yet data is unavailable to make an educated judgment for the specification or application of protective glazing. Meanwhile, PG is often installed improperly...threatening America's stained glass treasures.

This research project may save stained glass stewards countless dollars in needless PG installations and premature repair costs and restoration when installations cause or contribute to deterioration. The study may also help eliminate the practice of using protective glazing in place of proper stained glass conservation measures. Most importantly, a published record backed by hard facts may convince owners to protect stained glass properly for future generations, with or without PG. This information, collectively authored and presented here for the first time, will be invaluable to preservationists, stained glass studios, and architects in advising and specifying PG. The continued practice of installing improperly ventilated PG is creating a myriad of preservation problems. The result is the potential loss or replacement of many important historic stained glass windows.

PROMOTION AND USE OF PROTECTIVE GLAZING

The ever-changing face of religion (less active members), architecture (less complex designs), art (less ornamentation) and economy (less money) since the 1960s has resulted in greater competition for fewer stained glass installations. In order to stay in business, many stained glass studios and other window contractors have fully endorsed the use of PG as *"The only economical method of halting water seepage in an old window is to install permanent protective Lexan® or storm glass."*[2] The installation of PG has become a lucrative aspect of the glazing industry across the country. Stained glass studio literature collected since the 1960s reveals that most studios used at least some of the following reasons to promote PG to consumers including: vandalism, security, energy savings, comfort, conservation, weather damage, sound barrier, and less maintenance.

The results of this study show that claims of saving 50% on energy bills or quadrupling the life of stained glass by using PG are simply false advertising **[Appednix XX]**. No reliable studies substantiate such claims, including this one. The continued efforts of many stained glass professionals and preservation experts are effecting how PG is promoted in studio advertisements, videos and brochures. This study encourages professional presentation of what storm windows can and cannot do for stained glass.

Most studios have mentioned PG in advertisements and company brochures over the past several decades which provided an opportunity to review how PG is represented in company literature. The following sampling provides an array of promotional methods:

A contracting bid (not public information) from an Indianapolis stained glass studio lists the following advantages of using *Lexan®* as PG: *"reduce heating costs, reduce cooling costs, protect wooden millwork and eliminate need for continual repainting, protect valuable windows from vandalism... can quadruple your stained glass window life expectancy and save your congregation money every day."*

Lamb Studios (Philmont, NY) wrote an article based on a lecture to the Energy Task Force Workshop of the **Episcopal Urban Caucus**, Louisville, Kentucky in 1983 that was printed in the Journal of the Interfaith Forum on Religion, Art & Architecture. It claims *"by covering a stained glass window a church can save about 50% of the energy-- either heating in winter or cooling in summer."* The article further notes *"neither of the products (Lexan® from General Electric and Tuffack® from Rohm and Haas) will yellow over time."*

Shenandoah Studios (Front Royal, VA) advertised in Faith and Forum (IFFRA) in 1989 that *"Stained glass can be insulated for energy savings, remain watertight and weather resistant...concerns about weathering, vandalism, burglary or accidents are a worry of the past."*

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[2]First United Methodist Church, Ypsilanti, MI proposal by Hauser Studios, 1973.

Willet Studios (Philadelphia, PA) developed a full-color brochure that recommends the use of Lexan® as an overglaze. *"Meets or exceeds the strictest building code regulations for safety glazing...your church will be better insulated with ...Lexan® sheet...can reduce heat loss and lower fuel consumption by as much as 25%"*

Bovard Studio's (Fairfield, IA) 1991 newsletter provides a comprehensive view of PG: *"Benefits of PG are energy conservation, protection... from vandalism protection of stained glass, leading and frames from deterioration caused by weathering, hailstones, and pollution. But beware, improperly vented PG can create more damage than vandals throwing rocks...If condensation and humidity are not alleviated by proper air circulation, the leading and metal frame deteriorate to the point where structural integrity of the window is lost..PG alone is not a restoration technique or an alternative to proper maintenance of stained glass.*

Rohlf's Stained and Leaded Glass, Inc. (Mt. Vernon, NY), self-described as *"America's Foremost Stained Glass Conservators,"* printed a brochure that states *"Clear float, safety or tempered glass should be used for PG. Acrylic or polycarbonate should only be used in areas of severe vandalism, due to yellowing, frosting and not allowing the wood to breathe"*

David Wixon & Associates (Glen Ellyn, IL) printed a newsletter entitled "Stained Glass Technical Advisory" that reads *"DANGER ALERT!"* and contains three pages dedicated to the problems associated with improperly installed double glazing.

CONSUMER DEMAND FOR PROTECTIVE GLAZING

A series of events in the 1960s and early 1970s greatly intensified the use of PG in the United States. Civil unrest throughout the South and large northern cities motivated a number of congregations to cover their stained glass windows with PG in fear of vandalism. One church in Savannah, Georgia, revealed that the all-white congregation had PG installed during the early 1960s in direct response to verbal threats of destruction for their segregated philosophy. A Detroit church installed PG in response to bullet holes in their stained glass during the 1967 riots. Fear over vandalism and theft, whether justified or not, remains a powerful motivator for PG, especially in gang-infested inner-city neighborhoods. The 1973 oil embargo greatly increased the cost of fuel oil convincing many churches to add secondary glazing to conserve energy. In the January/February 1976 issue of Your Church magazine, a total of 338 persons responded to the property management survey. The survey asked whether the church had protective glass over the stained glass. Of the 70% who answered the question, 41% said their churches either had some form of PG or they were thinking about it. Field surveys by **Inspired Partnerships** estimates that 90% of the stained glass in Northeast, Midwest, and Rocky Mountain churches is covered with PG, and 70% of the stained glass in Southeast, South and West Coast churches is covered with PG.

Perhaps even more important than the fear of vandalism, or the concern over fuel bills is the financial inability of many congregations to fund stained glass restoration. The enormous popularity of stained glass in America between the Civil War and World War I has resulted in

countless large stained glass installations between 80 and 130 years old. Incidently, the life span of most leaded glass windows falls into this time span. Many dwindling congregations housed in large old churches are faced with the reality of expensive restoration costs and choose to defer the expense of restoration -- meanwhile buying the PG alternative over restoration. Regardless of the aesthetic or conservation impact on stained glass, PG stops leaks and drafts through deteriorated stained glass and postpones the inevitable restoration costs for someone else. Procrastination has been the decision of thousands of congregations across the country and today a vast majority of U.S. churches with stained glass have some type of PG. In recent years, a greater sense of stewardship, increasing professional criticism of PG and a growing "restoration" market is prompting the question, "Do we need protective glazing...or do we really need restoration?"

AWARENESS OF PROTECTIVE GLAZING PROBLEMS

British stained glass expert, Roy G. Newton, was among the first to rejuvenate the century-old concerns over PG in a CVMA Newsletter in April 1975. Lawrence Lee followed suit and included a brief mention of PG and its associated problems in his book entitled Stained Glass (Crown Publishers, New York) in 1976. Lee noted that *"experts recommend that for important windows, protective plain glass should be inserted into the window openings with the precious ancient glass remounted a little way inside."* This book, first published in England, generally refers to medieval glass. Nevertheless, Lee discusses condensation and aesthetic concerns as well as isothermal installations. This was the first time PG problems were mentioned in a U.S. publication.

An article in Stained Glass Quarterly (Winter 1983/84) discussed venting PG to the interior but is restricted to museum settings. This and subsequent issues discussed how PG might be damaging to stained glass windows. Julie Sloan boldly asked *"Protective Glazing: Is it Necessary?"* in her February 1987 article in Professional Stained Glass. Many important observations were presented in this review, however, the only research Ms. Sloan cited was The Deterioration and Conservation of Stained Glass: A Critical Biography by Roy G. Newton (London: Oxford Press) published in 1982. While the CVMA was not mentioned specifically, most of the information cited came directly from their research findings. Ms. Sloan did not perform or cite any additional tests or research to further support her position.

In 1988, The Census for Stained Glass Windows in America, published a booklet entitled Conservation and Restoration of Stained Glass: An Owner's Guide. Geared toward the caretakers of our nation's stained glass-- ministers, church custodians, and church lay committees -- the booklet contained a short discussion on PG. *"PG systems, when correctly installed, may greatly increase the longevity of historic glass, and may decrease the overall energy requirement of the buildings. When incorrectly installed, PG may detract from the aesthetic beauty of the windows and the building, and may set up conditions which may actually destroy the glass..."* It is significant that leaded, laminated and tempered glass with venting was encouraged while acrylics, polycarbonates without venting were discouraged.

Stained Glass Quarterly, Glass Art, Old House Journal, Traditional Building, The Clergy Journal and several not-for-profit preservation newsletters such as Common Bond, Inspired, and Amazing Space have printed articles since the mid 1980s detailing the hazards of PG. Many of these articles were reprints or reviews of previous publications. These articles were backed by personal experience and observations but lacked American research data to contradict unsubstantiated claims made by PG manufacturers and installers.

SGAA Reference & Technical Manual, A Comprehensive Guide to Stained Glass. The 1988 manual had an article (reprinted from Stained Glass, Summer 1982) by Viggo B.A. Rambusch where he stated that *"protective glass or acrylic plastic is very important...care should be taken in selecting the framing system...note that plastic is not flat but is rather wavy...weep holes or other venting systems (are necessary) for the air pocket between the stained glass and the protective element."* Several articles with references to PG were reprinted for the 1992 manual. However, even the most comprehensive book (785 pages) on stained glass in America, contains contradicting statements on PG installations pertaining to venting the air space. Nevertheless, it includes several important points regarding PG: 1) it is not a substitute for repair, restoration or maintenance; 2) the airspace should be vented to allow for any condensate to evaporate; to equalize air pressure; and to minimize the temperature gradient; 3) ventilation methods, and; 4) if plastic glazing is used, adequate provision must be made for significant expansion/contraction.

Copyrighted in 1993, Conservation of Stained Glass in America, A Manual for Studios and Caretakers, by Julie L. Sloan was not printed until January, 1995. Prior to the **Inspired Partnerships** study, Ms. Sloan's manual was the most extensive American resource on PG. Much of the text is taken from previous articles by the author in Professional Stained Glass and other publications, while the entire last chapter is dedicated to PG. As with many of her articles, there are few references cited. Ms. Sloan notes that unlike medieval glass, most types of 19th and 20th century glass are virtually impervious to most atmospheric pollution (as researched by Roy G. Newton). She also noted that energy conservation measures, such as lowering thermostats, are more cost effective than applying PG (although no data was included). Ms. Sloan further wrote that rain, in and of itself, actually washes a window of hygroscopic dirt. It is when condensation is trapped and allowed to collect on glass, surrounding lead cames, and metal or wood frames that deterioration to glass, paint, and frames will take place.

Sloan further notes that it is imperative for PG to have adequate ventilation to allow full air circulation and continuous exchange within the air space. She describes a number of conditions that influence whether PG should be vented to the exterior or interior including climate, building materials, and window orientation. She defines two categories of PG, plastic or glass. Acrylic and Lexan®, upon ageing will become less shatterproof and will scratch from air-blown particles. Sloan promotes laminated glass as the ideal PG. In terms of aesthetics, she suggests the use of leaded clear glass, either diamond leading or following the lead lines of the stained glass. This is expensive, and shadow lines can be seen from the inside, this method avoids a highly reflective surface created by large sheets of glazing. All plastics and plate glass must be installed in full sheets that are highly reflective and detract from the stained glass. She notes that framing materials must be compatible with the existing stained glass frame, and architecture.

The Stained Glass Association of America's Restoration and Repair Committee recently published Standards and Guidelines for the Preservation of Historic Stained Glass Windows (copyright, February, 1995). In reference to PG, this resource summarizes:

- Promotion of PG to save money due to energy conservation is not correct.
- Majority of American windows fabricated after 1850 do not need PG
- Exceptions are windows containing fragile paint, window composed of large, very thin pieces of glass, and some plated windows with irregular exterior plating that may encourage the infiltration of water between the plates.
- Primary purpose of PG is to protect the window from vandalism, and severe weather conditions.
- The interspace must be vented with screens, preferably to the exterior at the extreme bottom and top of the PG to encourage the movement of air through the interspace.

In recent years, the voices of numerous stained glass and preservation professionals have begun to congeal into a solid message that PG is not a substitute for restoration, and when improperly installed, can detract from the building's aesthetics and accelerate deterioration. This message is greatly strengthened by 1) SGAA Reference & Technical Manual. A Comprehensive Guide to Stained Glass; 2) Conservation of Stained Glass in America, A Manual for Studios and Caretakers; 3) Die Schutzverglasung - eine wirksame Schutzmaßnahme gegan die Korrosion an wertvollen Glasmalerieien; 4) Standards and Guidelines for the Preservation of Historic Stained Glass Windows; 5) Preservation Brief #33: The Preservation and Repair of Historic Stained and Leaded Glass; 6) Stained Glass in Houses of Worship, and; 7) this study for the **National Preservation Center**-- all seven resources were written in the past four years!

PROTECTIVE GLAZING QUESTIONNAIRE

Inspired Partnerships solicited input from the stained glass industry as part of this study through a questionnaire published in the Winter 1995 Stained Glass Quarterly which has a circulation of 5,000 copies. A similar questionnaire survey was mailed to the Studio and Artist/Designer members of the SGAA, various known stained glass artists who are not SGAA members, and non-profit religious and preservation organizations who will benefit from the study. Some questionnaires were sent to European individuals involved in PG concerns over the years. Approximately **200 questionnaires** were mailed or faxed (180 to stained glass practitioners and 20 to other interested parties) yielding 40 responses, all from stained glass studios. Disinterest, and reticence over taking a position before the final results of the study are published, ostensibly reduced the number of responses.

However, the 40 studios who responded literally represent hundreds of PG installations per year, and thousands of PG installations over the life of their companies. Some questions involved multiple responses while others were answered by short essays. Moreover, some respondents chose not to answer certain questions. Therefore, the final results are not scientific, but a general representation of the U.S. stained glass community. The geographic distribution included 17 states, Canada, England and Yugoslavia.

Over 62% responded ***"always or nearly always recommend the use of PG"***, with about the same number doing the actual installation. The decision for or against PG was almost equally made by the client or the studio. Reasons for encouraging PG ranged from 75% citing vandalism, 50% citing hail/high winds, and 50% citing energy savings, which represent the most common reasons expressed by congregations. Another 35% cited security or protection from glass deterioration. The top three reasons cited for discouraging the use of PG included: 35% negative impact on aesthetics, 25% condensation in the air space, and 25% heat build-up in the air space.

Nearly half of the respondents noted that they ALWAYS vent their PG installations. However, the national PG field survey strongly contradicts this response *{See Protective Glazing Field Survey}*. Half of the studios which responded do not offer any guarantees on their PG installations; only 18% offer a guarantee over five years. Polycarbonates (e.g. Lexan®) are used most often for PG, while standard sheet or plate glass were next. All materials considered, the use of glass and plastic products were equally divided among the respondents. The controversy involving venting in literature and seminars is a concern of many respondents. The source of industry information about PG indicates that nearly 85% of the respondents glean their information from stained glass publications or commercial glazing publications. Others rely on "word of mouth."

Very few respondents answered all the questions, choosing instead to ignore those questions which involved something other than simply checking a box. One respondent who declines the use of the firm's name in this study stated that the firm doesn't really recommend PG...they just do it to make money. *"When a church calls and wants it done, they are going to have someone do it and it might as well be us."*

Several firms discourage the use of plastic materials, unless vandalism is a major problem. Eventual yellowing, clouding and scratching were the reasons stated. One respondent from Florida felt that *"acrylics hold their clarity much better than polycarbonates when exposed to intense Florida sun."* Of the three respondents from Florida, two always vent (to the exterior) while one never vents; however this studio is waiting for more definitive research on American stained glass. All three are SGAA members. The one Canadian respondent (Saskatchewan) only vents to the inside, to prevent condensation; early experiments with outside venting resulted in condensation. Both studios from California and Washington feel venting is not necessary in their particular climates.

Most of the respondents started installing PG since the 1970s. Another 20% were installing PG in the 1940s-50s-60s, while only three of the respondents installed PG prior to 1940. The vast majority of the respondents were small studios of less than five people working full time. It was disappointing that only one of the ten largest studios in America responded to the questionnaire. Nevertheless, it was little surprise since these studios tend to rely on larger contracts which include more storm glazing -- they also tend to promote PG more in studio literature and have voiced more opposition to this study.

Protective Glazing Questionnaire

Inspired Partnerships recently received a 1995 National Preservation Center Grant to investigate the virtues and liabilities of various storm window ("protective glazing") installations over stained glass. This study will include analysis of deterioration, energy loss, security and aesthetic issues among other factors. The objective is to develop sound data to address the concerns and/or virtues of storm windows over stained glass. The goal is to publish the research data to help set industry standards for proper storm window installations over stained glass. This is a challenge to all those interested in improving industry standards, and in the preservation of both new and old stained glass. We hope you will help us in this important endeavor. **Please complete the questionnaire and mail or fax to:** Neal Vogel, Inspired Partnerships, 53 W. Jackson Blvd. Chicago, IL 60604 (312)-294-0085 FAX.

Firm Name (optional)_____ **Geographic Location**_____ **Date Firm Established**_____
Earliest PG installation of Firm_____ **Is it Still in Place (where)?**_____ **Have you replaced this PG at any time?**_____

How Often Do You Promote the Use of PG?
15___Always
10___Nearly Always
12___Specific Conditions Only
2___Rarely
___Never

How long are PG installations guaranteed?
19___No guarantee offered
4___1-5 years
5___5-10 years
2___10-20 years
___Over 20 years
(1 - we stand behind all our work)

What PG materials are used?
17___% Standard Sheet Glass (10-90%)
13___% Laminated Glass (5-100%)
12___% Tempered Plate Glass (5-90%)
21___% Polycarbonates (5-90%)
7___% Acrylics (5-100%)
___% Screens
4___% Other (thermalpane)
(1 - leaded lights 60%)

When Do You Vent PG installations?
18___% Always Vent (regardless of location)
7___% Never Vent
___% South Elevation
___% West Elevation
___% East Elevation
___% North Elevation
(3 - rarely or depends)

Reasons You Encourage PG?
30___Protects from Vandalism/Accidents
14___Protects from Glass Deterioration
5___Protects from Paint Deterioration
23___Protects from High Winds/Hail/Weather
14___Security
10___Sound Barrier/Acoustics
7___Prevents drafts/dirt infiltration
2___Required by Church Insurance Company
21___Energy Savings
___Temporary Solution to Restoration
___Improved Appearance
10___Specified by Architect/Consultant

Who generally installs your PG?
24___% Our company
10___% Outside contractor

What guarantees, if any, are offered?
3___Wind damage
2___Vandalism
4___Energy Savings
1___Less noise transmission

Typical Depth of Airspace (installed)?
3___¼"
8___½"
12___1"
3___1½"
7___2"+
(5 - 3/4")

Reasons You Discourage PG?
9___Condensation in Air Space
10___Heat Build-up in Air Space
1___Minimal Energy Benefit (poor payback)
4___Cost of Installation
1___Elimination of Natural Ventilation
6___Historic/restoration authenticity
8___Discoloration
2___Discourages Window Maintenance
___Fire Dept. Barrier (for venting fires)
___Specified by Architect/Consultant
14___Aesthetic impact on exterior
4___Aesthetic impact on interior (shadows)

Decision for/against PG generally made by?
13___% Our company
17___% Church (client) committee
___% Insurance Company
___% Outside Contractor
___% Other (_____)

Which kind of PG do you use?
18___% Single storm
7___% Double glazed (thermalpane)
1___% Triple glazed
___% Thermally broken
___% Non-thermally broken

Source of industry information on PG
20___Stained glass publications
14___Commercial glazing publications
13___Word of Mouth
7___Other (experience, seminars)

Thank you for your time and input. Please respond to these additional questions on the back, if possible.

1. Please identify the oldest PG installation you have seen and its location. (mostly unanswered)
2. Please identify any insurance company which requires PG for stained glass coverage. (NONE)
3. Please describe how you vent. (7) holes/screens; (5) gaps; (2) screened louvers; (3) no putty; (2) to the inside
4. Please describe the framing materials you typically use and how they are installed in the opening.
5. Please discuss any situation which caused you to change from one PG material to another. (abrasion of plastics)
6. Why did you first recommend PG for stained glass? (11-vandalism, 8-weather, 6-insulation, 3-protect st. gl)
7. Does your company retrofit PG on your older installations, or those of others? (mostly unanswered)
8. Please identify industry problems/concerns about PG which you have observed.(Discussion about venting, use of plastics)
9. Has your position changed on the use or venting of PG installations over the years.(mostly unanswered)
10. Which local, state or national industry associations do you belong to? (mostly unanswered)

LOCATION OF RESPONDENTS
AR (2), AZ (2), CA (1), FL (3), IL (2), KS (1), ME (1), MI (5), MD (1), NC (2), NJ (1), OH (2), OK (2), PA (3), TX (2), WA (1), WI (3).
CAN (1), ENG (2), YUG (1)

PROTECTIVE GLAZING FIELD SURVEY

Inspired Partnerships performed a field survey of 100 PG installations from March, 1995 to March, 1996. The **Committee** suggested four regional areas to be surveyed based on their climate, concentration of PG installations, and potential for minimizing travel costs. These included: **Portland-Tacoma-Seattle** in the Northwest (temperate/wet); **Tucson-El Paso-Albuquerque-Phoenix** (hot/dry) in the Southwest, **Chicago** in the Midwest (cold/wet), and **Savannah-Charleston** in the Southeast (hot/wet). Each area provided valuable insight on PG installations, and collectively gave a strong national perspective on the PG industry which is summarized in this section. In addition, five of the nine members of the **Advisory Committee** have considerable professional experience in the Northeast and Mid Atlantic areas as well, including Boston, New York City, Philadelphia, and Washington, D.C.

The **Committee** developed the following criteria for selecting PG installations in the field:

1. **Variety of window settings (wood, masonry, steel)**
2. **Variety of stained glass (painted glass, plated windows)**
3. **Variety of PG (acrylics, polycarbonates, glass)**
4. **Variety of aesthetics (good, bad, mediocre)**
5. **Variety of installations (vented, unvented, fixed)**

The **Committee** also established the methodology to use during the field survey of the 100 PG installations using a survey form developed by **Committee** member, Arthur J. Femenella:

1. **Surface temperature of glass & lead (when feasible)**
2. **Outside and inside ambient temperature**
3. **Outside and inside ambient humidity**
4. **Relative humidity in air space (when feasible)**
5. **Description of installation and general conditions**
6. **Expanded visual inspection/comments on condensation**
7. **Date and time measurements were taken**
8. **Orientation of window**
9. **Document and photograph all installations**
10. **Note weather conditions**

SUMMARY OF 100 INSTALLATIONS:

Although various aspects of the PG Field Survey installations are drawn upon throughout this study, particularly in **SECTION III.**, all 100 installations are collectively evaluated here. An effort was made to select PG installations at random, which was a necessity due to limited travel costs in every region but Chicago. Most installations were selected on a first-seen basis, while trying to adhere to the selection criteria developed by the **Committee**. The 25 installations in Chicago, however, were essentially hand-picked from the thousands of available installations based on the selection criteria.

In terms of window orientation, the survey was concentrated on the east (31%), south (40%) and west (27%) windows, since north windows are not effected by solar gain in the Continental U.S. **[FIG 1.]**. Among the windows surveyed, 40% are a simple rectangular or round-arch window, while 60% are gothic-arch or rose windows with tracery **[FIG 2.]**. Window height from the ground was recorded since improved security is often cited to warrant protective glazing; 22% are within five feet of the ground, 30% are between five and ten feet above ground; and 48% are over ten feet above ground (up to 40 feet) **[FIG 3.]**. The exact type of PG material was recorded when it could be determined, otherwise it was simply grouped into plastics (23%) or glass (27%). The breakdown of PG materials employed is: polycarbonates (31%); acrylics (14%), tempered glass (3%), laminated glass (1%), and fiberglass (1%). Therefore, as a group, plastic products accounted for approximately 70% of the windows surveyed. The age of the installation was also recorded when known.

In terms of their condition, over half of the installations (both glass and plastic) appeared "dirty." Usually the dirt was found on the inside surface of the PG. Nearly all of the plastic installations are discolored, scratched or hazed and church members are displeased with their appearance **[FIG 4.]**. About 15% are too discolored to see the stained glass at all. The few (5%) of the plastic installations that are not discolored, scratched or hazed are less than two years old. Approximately half of the installations are set into a sub-frame, typically aluminum, which clashed with the building's historic materials and aesthetics. Another 23% prevent the window ventilators from operating.

Ironically, although response to the questionnaire signify that most studios vent their PG installations, only 4% of those surveyed in the field were intentionally vented **[FIG 5.]**. Another 19 have self-vented over time due to deteriorated sealants or broken glazing **[FIG 6.]**. The depth of the air space varies greatly and is usually contingent upon the window frame and ease of installation, over 75% are set more than 1" from the stained glass. Condensation is unquestionably a problem with PG installations as evidence of condensation was found in nearly 70% of the windows; while 10% of the windows were too obscured to see at all. As expected, the Southwest installations, that are located in regions where the average relative humidity is below 20%, generally had little or no evidence of condensation. Glass temperatures, measured in direct sunlight were always higher than ambient indoor or outdoor temperatures, averaging between 18°F and 21°F higher. The temperatures varied depending on the color of the glass, wind speed, and how long the window had been exposed to direct sunlight at the time of testing.

Despite recorded heat and condensation problems, the stained glass and glass paints were in good condition overall, while the leading, bracing and frame of the windows were deteriorating. However, a number of these windows have been repaired or braced (many *in situ*) over the past 20 years. These conditions seem to correlate with the quality of the window's construction. High-quality windows by reputable American studios and imported windows (primarily English and German) were in better condition than generic windows. Their superior condition can be generally attributable to better bracing, leading, and design. Low-end generic windows with thin (1/8"), flat lead cames, were deforming the worst. Although their internal condition is unknown, none of the plated windows revealed any serious deterioration on the surface.

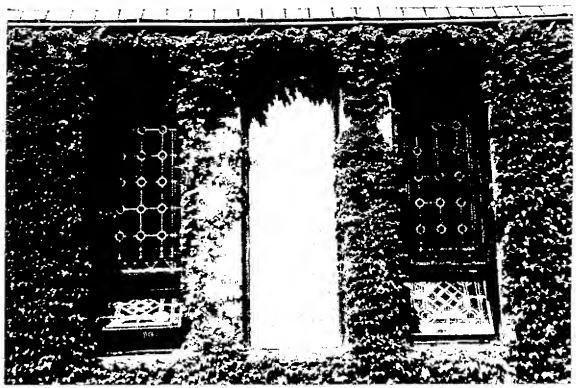

Fig 1. Most of the windows were tested in direct sunlight.

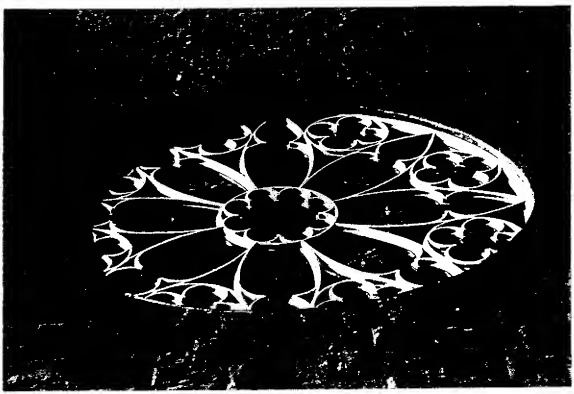

Fig 2. Approximately 60% of the windows surveyed had intricate tracery.

Fig 3. Security was not an issue for most of the windows.

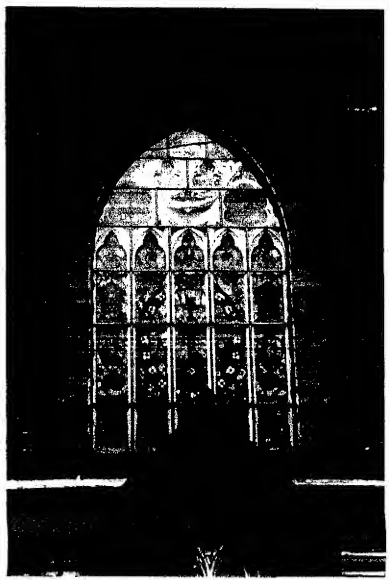

Fig 4. Nearly all plastics have badly hazed and yellowed.

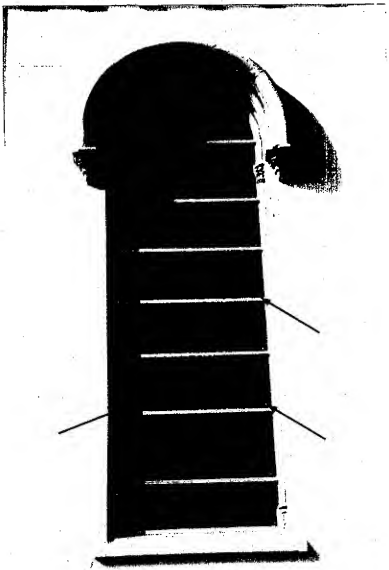

Fig 5. Only 4% of the PG surveyed was intentionally vented.

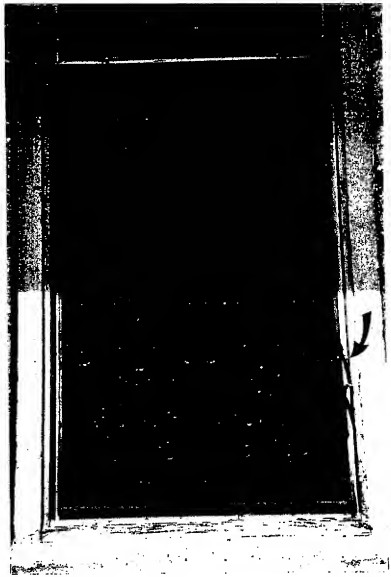

Fig 6. Many windows have self-vented as sealants breakdown.

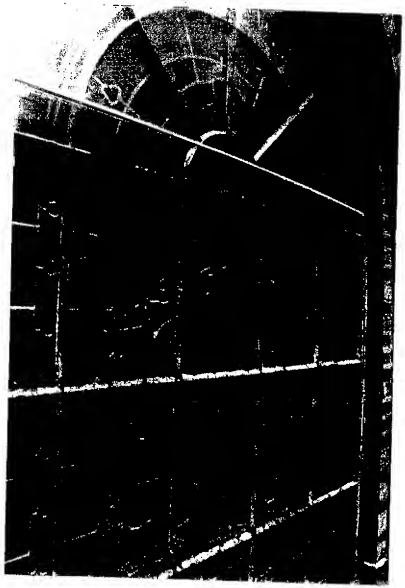

Fig 7. Glazing sealants and frames often deteriorate behind PG.

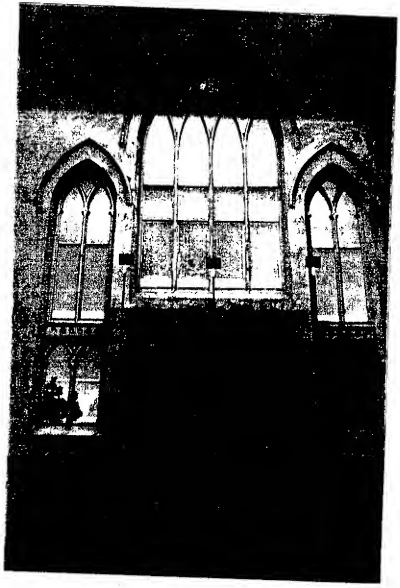

Fig 8. PG can be integrated with the original tracery.

Nevertheless, the waterproofing (cement) was missing in areas on 40% of the windows and had completely failed on another 22% -- regardless of their quality. Moreover, the perimeter sealants had partially or totally failed on half of the PG installations. The PG definitely prevents proper window maintenance; approximately one-third of the windows surveyed required maintenance to the metal or wood frames, which were not accessible due to the PG **[FIG 7.]**.

GROUP A, PACIFIC NORTHWEST (surveyed in April, 1995):

There are fewer pre-W.W.II churches in the Northwest compared to other areas in the country and, perhaps due to limited sunshine, there are comparatively few stained glass installations. This area took several weeks to survey since sunshine was sparse, yet necessary to test for heat build-up and surface temperature of the stained glass. One of the oldest PG installations found in the Northwest was located at the Congregation Beth Israel synagogue and appears original to the 1927 construction. Despite the mild Northwest climate, most of the stained glass is covered with protective glazing. Due to predominately mild temperatures, ventilators are only found on 25% of the stained glass windows so PG has less impact on church ventilation than many other regions in the U.S. None of the churches surveyed had air-conditioning. The most obvious problem with PG in the Northwest was the creation of an interspace which traps moisture in a very damp climate. Evidence of moisture was readily apparent on 80% of the installations and over 20% of the frames had some degree of corrosion or rot.

GROUP B, SOUTHWEST (surveyed in June, 1995):

Protective glazing installations were difficult to find in the Southwest which required an 800+ mile trek through Arizona, New Mexico and southern Colorado. Most of the installations were found in older Southwest towns and cities such as Albuquerque, NM, El Paso, TX, Bisbee and Prescott, AZ, and Durango, CO. The extremely dry climate revealed fewer problems with condensation. When present, condensation seem to be related to air conditioning or evaporators known as "swamp coolers." As expected, approximately 80% of the churches surveyed had air conditioning. The Southwest churches also generally had lower roofs with wider overhangs that shaded the side walls and stained glass from direct sunlight. However, the intense sunlight on exposed windows, particularly plastic materials with high coefficients of expansion/contraction, was consistently causing failure of perimeter sealants. Despite the blistering daily temperatures, often over 90°F during the field survey, few of the windows surveyed had deformation problems. Unfortunately many of the windows were installed or restored after 1950. Many Southwest congregations have the resources to keep their buildings well maintained.

GROUP C, CHICAGO-LAND (surveyed between March 1995 and March 1996):

There are literally thousands of protective glazing installations in the Chicago area, yielding the greatest variety of installations to select from. Crime and vandalism rates around the third largest city in the U.S., coupled with brutal winter weather, has encouraged the vast majority (over 90%) of churches to cover their stained glass with PG. Most of the stained glass in Chicago was installed during the late 19th and early 20th century and is, therefore, between 80 to 100 years old. PG installations also tend to be older in the Chicago area than the other three areas surveyed with installations dating back to the early 20th century. The condition of stained glass in Chicago, whether covered by PG or not, is also worse than the other three regions

surveyed. Demographic shifts and suburban flight have left many inner city churches in despair with very limited resources. Expensive stained glass restoration is often near the bottom of their building priorities. Here, more than any other region surveyed, PG is sought as a temporary solution to buy time and postpone restoration while the congregation struggles to find new growth and financial independence. Unfortunately, this common lack of resources is coupled with the most severe weather conditions of the four regions with the highest seasonal temperature and humidity swings and freeze-thaw conditions. The combination of these cultural, economic and environmental conditions motivate many urban churches to install PG. Unfortunately, the PG layer becomes another aspect of the window to maintain on top of its first-investment cost.

GROUP D, SOUTHEAST (surveyed in July, 1995):

Charleston, SC, and Savannah, GA were selected for their concentration of historic churches, strong preservation movement, good church documentation, and vulnerability to hurricanes. Surprisingly, several of the churches without PG suffered no stained glass damage from Hurricane Hugo in 1989. Other windows covered with PG actually had the entire window (frame and all) blown out of the window opening. Exposed stained glass is very resistent to wind pressure, but is vulnerable to flying objects. The vast majority of stained glass damage resulting from Hurricane Hugo was caused by flying roofing and siding materials, branches or debris hurled into the windows as opposed to wind or rain from the storm itself. All but one of the Southeast churches were air conditioned, and most of air conditioning systems were on during the field survey. Combined with high relative humidity, which averaged between 50% and 60%, the air conditioned interiors were causing the worst condensation problems observed anywhere. Congregations located in strong preservation communities like Charleston and Savannah, tend to integrate PG more carefully within the original window frame and tracery **[FIG 8.]**.